Mitigation of impacts from large-scale hardrock mining in the Bristol Bay watershed

by

Thomas G. Yocom[1] and Rebecca L. Bernard[2]

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Executive summary:

The U.S. Environmental Protection Agency (EPA) has evaluated the potential impacts and risks of large-scale hardrock mining projects in a portion of the Bristol Bay watershed drained by the Nushagak and Kvichak River systems. The EPA's draft Bristol Bay Watershed Assessment (BBWA) did not assess the likelihood that impacts, such as those to streams, open-water habitats, and adjacent wetlands might be offset by mining project sponsors, thereby reducing net project impacts. In fact, the sponsors of one such project, the proposed Pebble Mine, considered the EPA's lack of focus on mitigation to be a serious flaw in its draft BBWA.[3] The purpose of this paper is to evaluate whether there are practicable compensatory mitigation measures that could offset the impacts of such a mining project, in particular the proposed Pebble Mine, enough to satisfy the permitting requirements under Section 404 of the Clean Water Act (CWA).

In 2008, the EPA and the U.S. Army Corps of Engineers (Corps) promulgated and adopted regulations governing how impacts to wetland and aquatic habitats are to be offset through compensatory mitigation. These rules recognize that impacts must be avoided where practicable and minimized to the maximum extent feasible. They also offer flexibility by allowing methods such as mitigation banks, in-lieu fee mechanisms, and preservation of existing habitats, in addition to more traditional habitat restoration and enhancement projects undertaken by project sponsors.

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[1] Thomas G. Yocom is former National Wetlands Expert, U.S. Environmental Protection Agency, San Francisco, CA. Mr. Yocom retired from the EPA in 2005.

[2] Rebecca L. Bernard is Of Counsel, Bessenyey & Van Tuyn, LLP, an Anchorage law firm providing legal counsel to the Bristol Bay Native Corporation (BBNC) on matters related to responsible development in Bristol Bay. The authors would like to acknowledge the support of BBNC for, and the contributions of Dr. Carol Ann Woody and Sarah L. O'Neal to, the preparation of this document.

[3] The Pebble Limited Partnership (PLP) stated that the draft BBWA "*neglects to take into account the extensive mitigation measures that will be implemented to offset potential impacts from mining - measures that must be reviewed and approved during the rigorous Clean Water Act Section 404 permitting process and associated reviews pursuant to the National Environmental Protection Act, Endangered Species Act, and other federal and state regulatory programs.*" For this and other reasons, PLP asserted that "*the environmental and habitat impacts described in the Assessment have been grossly overstated.*" Letter from John Shively, Pebble Limited Partnership, to the U.S. EPA, Washington, D.C. (July 23, 2012).

This document describes the compensatory mitigation rules that would apply during the Section 404 permitting process for a large-scale mining project within the Bristol Bay watershed. In estimating the potential scale of impacts that might require mitigation, a 25-year project footprint for mining the Pebble ore deposit (as described in Ghaffari et.al. 2011) was utilized, recognizing that actual impacts might be considerably larger if the deposit is mined for 45 years or more.

This document focuses exclusively on compensatory mitigation for impacts to wetland and aquatic sites and does not evaluate other potential mining project impacts, such as those to water quality and stream flows. Accordingly, it assesses only the likelihood that the sponsor of a large-scale hardrock mine in the Bristol Bay watershed could sufficiently offset project losses of wetland and aquatic habitats to qualify for a permit pursuant to Section 404. This document concludes that it could not.

The wetland and aquatic habitats in the Bristol Bay watershed are generally pristine. There are no approved mitigation banks that serve the areas of the Bristol Bay watershed where hardrock mining projects are likely. Similarly there are no in-lieu fee sponsors that have projects in these areas that could adequately offset mining impacts. Even if there were mitigation banks or in-lieu fee providers, the thousands of acres of wetland and aquatic impacts that would need to be offset would overwhelm whatever credits such mitigation vehicles might provide.

There may be some limited opportunities for permittee-responsible mitigation through restoration of degraded areas associated with past mining, and some similarly limited opportunities to improve fish passage around or through man-made obstructions, but these options would provide a small fraction of the mitigation burden, and would likely entail perpetual maintenance that would make them undesirable to project sponsors and agencies alike.

The size, unique nature, and permanence of habitat losses associated with large-scale hardrock mining in the Bristol Bay watershed are unlikely to be offset adequately through compensatory mitigation and the impacts therefore would be unacceptable and not permittable under Section 404 of the Clean Water Act.

Introduction:

Compensatory mitigation measures are commonly used during the Clean Water Act Section 404 permitting process to reduce or offset losses of aquatic resources and functions resulting from the permitted discharges. Offsetting large-scale impacts in pristine environments, however, may be neither feasible nor effective in replacing lost functions, due to the lack of opportunities for aquatic resource restoration, enhancement, or preservation of similar resources. This document seeks to assess the potential options for compensatory mitigation for losses of anadromous fish streams, their tributaries, open-water habitats, and adjacent wetlands from one or more large-scale hardrock mines as addressed by the U.S. Environmental Protection Agency (EPA) in its draft Bristol Bay Watershed Assessment (BBWA). This document assesses the likelihood that any of these potential options for compensatory mitigation could offset impacts of the magnitude that are likely to result from one or more large-scale hardrock mines within the Bristol Bay region.[4]

The specific focus of this document is the proposed Pebble Mine. The mine would be constructed in the pristine headwaters of the Koktuli River and Talarik Creek watersheds within the broader Nushagak-Kvichak watershed in the Bristol Bay region of Alaska. The potential mine poses particular challenges with respect to compensatory mitigation because of the sheer size of the impact (thousands of acres of streams and wetlands would be filled), the largely pristine environment, and the special ecological functions of the headwater streams and wetlands that would be filled. Given the pristine nature of the Bristol Bay watershed and its status as a highly productive and sustainable salmon factory, an analysis of compensatory mitigation options for large-scale metallic sulfide mines within these drainages should be representative of compensatory mitigation that would be required for such mines in other drainages in Bristol Bay.

Regulatory Background:

To achieve its declared goal of eliminating the discharge of pollutants into the navigable waters by 1985,[5] the federal Clean Water Act (CWA), among other measures, prohibits the discharge of pollutants into the "waters of the United States" except as specifically permitted by the Act.[6] Section 404 of the CWA authorizes the U.S. Army Corps of Engineers (Corps) to issue permits for the discharge of dredged or fill material,[7] which is defined as a pollutant under the CWA regulations.[8] In determining whether to issue such permits, the Corps applies CWA regulations

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[4] This document does not attempt to address the likelihood that short- or long-term potential impacts to water quality and stream flows can be mitigated to levels considered permittable. These mitigation challenges may be as great or greater than those assessed in this document.
[5] *See* 33 U.S.C. § 1251(a)(1).
[6] *See* 33 U.S.C. § 1311(a).
[7] *See* 33 U.S.C. § 1344(a).
[8] *See* 40 C.F.R. § 122.2 (for purposes of the Clean Water Act, *"pollutant" means "dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended . . ., heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.").*

promulgated jointly by the Corps and the EPA (referred to as the 404(b)(1) Guidelines).[9] The goal of the 404(b)(1) Guidelines, as of the CWA, is to "*restore and maintain the chemical, physical, and biological integrity of the Nation's waters*" through the control of discharges of dredged or fill material.[10] The primary mechanism of the Guidelines for achieving this purpose is avoidance of impact to waters of the U.S., including wetlands:

> *Fundamental to these Guidelines is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern.*[11]

Where a discharge of dredged or fill material into "waters of the U.S." is unavoidable, the impacts of the discharge to the physical, chemical, and biological integrity of those waters must be minimized and offset.

The regulations that govern discharges of dredged or fill material follow this hierarchy in determining if the discharges can be authorized. The 404(b)(1) Guidelines prohibit the authorization of discharges where:

1. There is a practicable alternative that would have less adverse impact on the aquatic environment (LEDPA);
2. The discharges would violate an applicable State water quality standard or toxic effluent standard, would jeopardize the continued existence of an endangered or threatened species or destroy or adversely modify its designated critical habitat, or would violate any requirement imposed to protect a marine sanctuary;
3. The discharges would cause or contribute to significant degradation of waters of the U.S.; <u>or</u>
4. Appropriate and practicable measures have not been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.[12]

The Corps must deny authorization of any proposed discharge that does not comply with <u>all</u> of these restrictions.[13] For example, even where appropriate and practicable measures have been taken to minimize potential adverse impacts of the discharge, the Corps must deny the permit if the discharge still would cause or contribute to significant degradation of waters of the U.S. In addition, the Corps must deny a permit where "*there does not exist sufficient information to make a reasonable judgment as to whether the proposed discharge will comply with these*

[9] 40 C.F.R. part 230 (404(b)(1) Guidelines).
[10] 40 C.F.R. § 230.1(a); 33 U.S.C. § 1251(a).
[11] 40 C.F.R. § 230.1(c).
[12] 40 C.F.R. § 230.10(a)-(d).
[13] *See* 33 C.F.R. § 323.6(a) ("*Subject to consideration of any economic impact on navigation and anchorage pursuant to section 404(b)(2), a permit <u>will be denied</u> if the discharge that would be authorized by such a permit would not comply with the 404(b)(1) guidelines. If the district engineer determines that the proposed discharge would comply with the 404(b)(1) guidelines, he will grant the permit unless issuance would be contrary to the public interest.*") (Corps Section 404 regulations) (emphasis added).

Guidelines."[14] In other words, if a District Engineer cannot determine if a large mining project represents the LEDPA or, after considering proposed compensatory mitigation measures, whether it would or would not cause or contribute to significant degradation of the waters of the United States, the regulations direct the Corps to deny the permit application.

Compliance with these regulations has been required for all authorized discharges since 1986. In 1990, the Department of the Army and the EPA entered into a Memorandum of Agreement (MOA) on mitigation, that further confirmed the mitigation sequence of, first, avoiding impacts, second, taking measures to minimize unavoidable impacts, and finally, offsetting unavoidable impacts.[15]

In spite of this interagency agreement, compensatory mitigation measures were found to be unsuccessful, insufficient and, in some cases, not even implemented as required under Army Corps permits. In 2001, the National Academy of Sciences documented these failings and produced a report making several recommendations to improve the success of compensatory mitigation under the 404 regulatory program.[16] This study, as well as many others, led the Corps and the EPA to promulgate new regulations in 2008 to govern implementation of compensatory mitigation in the 404 permitting program.[17] The goal of the new regulations, known as the 2008 Mitigation Rule, is to "*promote no net loss of wetlands by improving wetland restoration and protection policies, increasing the effective use of wetland mitigation banks and strengthening the requirements for the use of in-lieu fee mitigation.*"[18]

The 2008 Mitigation Rule confirmed the "avoid, minimize, and offset" sequence for mitigation and emphasized that a permit may not be issued where there is a "*lack of appropriate and practicable compensatory mitigation options.*"[19] Under the 2008 Mitigation Rule, "*[t]he fundamental objective of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts to waters of the United States authorized by [Section 404] permits.*"[20] Compensatory mitigation must be determined "*based on what is practicable and capable of compensating for the aquatic resource functions that will be lost as a result of the permitted activity.*"[21] Furthermore, "*[c]ompensatory mitigation requirements must be commensurate with the amount and type of impact that is associated with a particular [Section 404] permit.*"[22]

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[14] 40 C.F.R. § 230.12(a)(3)(iv) (emphasis added).

[15] *See* Memorandum of Agreement between the Environmental Protection Agency and the Department of the Army concerning the determination of mitigation under the Clean Water Act Section 404(b)(1) Guidelines (Feb. 6, 1990). Importantly, this MOA states that compensatory mitigation "*may not be used as a method to reduce environmental impacts in the evaluation of the least environmentally damaging practicable alternatives for the purposes of requirements under Section 230.10(a)*" – in other words, impacts must be avoided and/or minimized first, regardless of the compensatory mitigation measures that may be proposed by a permit applicant.

[16] National Research Council. 2001. Compensating for Wetland Losses under the Clean Water Act. Committee on Mitigating Wetland Losses, Board on Environmental Studies and Toxicology, Water Science and Technology Board, Division on Earth and Life Studies. National Academy Press. Washington, D.C.

[17] *See* 40 C.F.R. §§ 230.91 - 230.98 and 33 C.F.R. §§ 332.1 - 332.8.

[18] *See* http://water.epa.gov/lawsregs/guidance/wetlands/upload/MitigationRule.pdf (last visited Sept. 25, 2012).

[19] 40 C.F.R. § 230.91(c)(3). "*Practicable means available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.*" *Id.* § 230.91(c)(2).

[20] 40 C.F.R. § 230.93(a)(1).

[21] *Id* (emphasis added). In determining what compensatory mitigation will be "*environmentally preferable,*" the Corps "*must assess the likelihood for ecological success and sustainability, the location of the compensation site*

Methods of available compensatory mitigation that may be considered are restoration, enhancement, establishment, and, under certain narrow circumstances, preservation, with an expressed preference for restoration.[23] Preservation is an acceptable form of compensatory mitigation only where all of the following criteria are met:

> (i) The resources to be preserved provide important physical, chemical, or biological functions for the watershed;
> (ii) The resources to be preserved contribute significantly to the ecological sustainability of the watershed. In determining the contribution of those resources to the ecological sustainability of the watershed, the district engineer must use appropriate quantitative assessment tools, where available;
> (iii) Preservation is determined by the district engineer to be appropriate and practicable;
> (iv) The resources are under threat of destruction or adverse modifications; and
> (v) The preserved site will be permanently protected through an appropriate real estate or other legal instrument (*e.g.*, easement, title transfer to state resource agency or land trust).[24]

The order in which the Corps is to consider types and locations of mitigation options is as follows: (1) mitigation bank credits, where available; (2) in-lieu fee program credits, where available; (3) permittee-responsible mitigation under a watershed approach; (4) permittee-responsible mitigation through on-site and in-kind mitigation; and (5) permittee-responsible mitigation through off-site and/or out-of-kind mitigation.[25]

The 2008 Mitigation Rule emphasizes a watershed approach: "*In general, the required compensatory mitigation should be located within the same watershed as the impact site, and should be located where it is most likely to successfully replace lost functions and services . . . .*"[26] The goal of this approach is to "*maintain and improve the quality and quantity of aquatic resources within watersheds . . . .*"[27] Watershed is defined as "*a land area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ultimately the ocean.*"[28] Among other factors, the watershed approach must consider "*how the types and locations of compensatory mitigation projects will provide the desired aquatic resource functions . . . .*"[29] This means selecting mitigation projects that will provide not just a single function, but "*where practicable, the suite of functions typically provided by the affected aquatic resource.*"[30] Although the Corps has flexibility to define the scale of the "watershed," it is important that it "*not be larger than is appropriate to ensure that the aquatic resources provided through*

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relative to the impact site and their significance within the watershed, and the costs of the compensatory mitigation project." *Id.*

[22] *Id.* (emphasis added).
[23] 40 C.F.R. § 230.93(a)(2).
[24] *Id.* § 230.93(h).
[25] *Id.* § 230.93(b).
[26] 40 C.F.R. § 230.93(b)(1); *see also id.* § 230.93(c)(1) (Corps must use a watershed approach to compensatory mitigation where appropriate and practicable).
[27] *Id.* § 230.93(c)(1).
[28] *Id.* § 230.92.
[29] *Id.* § 230.93(c)(2).
[30] *Id.*

compensation activities will effectively compensate for adverse environmental impacts resulting from activities authorized by [Section 404] permits."[31] Selection of the mitigation site focuses on replacing lost function,[32] and in-kind mitigation is preferred over out-of-kind mitigation because it is most likely to compensate for lost function.[33] In-kind "rehabilitation, enhancement, or preservation" is particularly emphasized for difficult-to-replace resources like streams (and, though not expressly stated, presumably headwaters wetlands that provide unique functions and services that are difficult to replace).[34]

The amount of compensatory mitigation required must be, "*to the extent practicable, sufficient to replace lost aquatic resource functions.*"[35] A functional or conditional assessment should be used to determine the proper amount; if one is not available, "*a minimum one-to-one acreage or linear foot compensation ration must be used.*"[36] A compensation ratio greater than one-to-one is required where, among other things, the mitigation method is preservation, the likelihood of success is at issue, the aquatic resources lost and replaced are different, the mitigation site is distant from the impact site, or the lost functions are difficult to restore.[37]

The 2008 Mitigation Rule also requires that compensatory mitigation occur, to the extent practicable, in advance of or concurrent with the permitted impacts, and that the permittee provide financial assurances.[38] The Rule requires a mitigation plan for each compensatory mitigation project, containing: 1) objectives; 2) site selection criteria; 3) site protection instruments (such as conservation easements); 4) baseline data (for impact and compensation sites); 5) a valid methodology for determining mitigation credit; 6) a work plan; 7) a maintenance plan; 8) ecologically based performance standards; 9) monitoring requirements; 10) a long-term management plan; 11) an adaptive management plan to deal with unforeseen problems; and 12) financial assurances to ensure that the compensatory mitigation plan continues to be successful in the future.[39] The plan must also contain ecological performance standards designed to ensure the mitigation project achieves its objectives.[40] The Rule addresses monitoring and management of mitigation projects,[41] and provides detailed rules governing mitigation banks and in-lieu fee programs.[42]

It is noteworthy that the preamble to the 2008 Mitigation Rule explicitly recognizes the continuing applicability of the May 13, 1994, "Statements on the Mitigation Sequence and No Net Loss of Wetlands in Alaska," issued by the EPA and the Department of the Army as part of the Alaska Wetlands Initiative Final Summary Report.[43] This guidance recognizes an

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[31] *Id.* § 230.93(c)(4).
[32] *Id.* § 230.93(d)(1).
[33] *Id.* § 230.93(e)(1).
[34] *Id.* § 230.93(e)(3).
[35] *Id.* § 230.93(f)(1).
[36] *Id.*
[37] *Id.* § 230.93(f)(2).
[38] *Id.* § 230.93(m), (n).
[39] *Id.* § 230.94(c).
[40] *Id.* § 230.95(a).
[41] *Id.* §§ 230.96, 230.97.
[42] *Id.* § 230.98.
[43] *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule*, 73 FED. REG. 19594, 19619 (Apr. 10, 2008) (citing *Statements on the Mitigation Sequence and No Net Loss of Wetlands in Alaska*, Memorandum from

interagency policy understanding that compensatory mitigation is not always warranted or practicable within the State of Alaska, even though this policy seems contrary to 1) the goal of the CWA to restore and maintain the physical integrity (reach and extent) of the nation's waters, including wetlands and 2) the national no-net-loss-of-wetlands policy with which it attempts to find harmony. The 1994 policy states, in part, that "*it may not be practicable to provide compensatory mitigation through wetlands restoration or creation in areas where there is a high proportion of land which is wetlands. In cases where potential compensatory mitigation sites are not available due to the abundance of wetlands in a region and lack of enhancement or restoration sites, compensatory mitigation is not required under the Guidelines.*"[44]

In spite of this seemingly contradictory approach to "no net loss," it seems clear that the EPA and the federal agency team that participated in the 1994 Alaska Wetlands Initiative intended that it apply primarily to small projects with minimal impacts. In its background discussion developing this policy, EPA et al. (1994) notes that 251 individual permits and 654 general permits[45] were issued by the Corps, Alaska District in 1993, of which 11 had been required to provide compensatory mitigation.[46] The 11 projects where compensatory mitigation was required provided 226 acres of wetlands mitigation (an average of approximately 20 acres per project). For the remaining 240 individual and 654 general permitted activities for which compensatory mitigation was not required, the average net loss per authorization was approximately one acre.

In subsequent guidance specifically applicable to Alaska, the Corps Alaska District, clarified what project impacts will require compensatory mitigation pursuant to Section 404 of the CWA under the 2008 Mitigation Rule. Its 2009 Regulatory Guidance Letter (RGL ID No. 09-01) lists types of projects that <u>always</u> require compensatory mitigation including those requiring "*fill placed in anadromous fish streams and wetlands adjacent to anadromous fish streams.*"[47] The RGL also identifies compensatory mitigation ratios that apply in Alaska. For waters in the "high" compensation category, as those in the Koktuli River and Upper Talarik Creek headwaters region would likely be, the required ratio is at least 2:1 for restoration and/or enhancement and at least 3:1 for preservation.[48]

Robert H. Wayland, III (EPA) and Michael L. Davis (Army) to Alvin L. Ewing, Alaska Operations Office, EPA Region 10 (May 13, 1994), *available at* http://www.epa.gov/owow/wetlands/pdf/alask.pdf.

[44] *Statements on the Mitigation Sequence and No Net Loss of Wetlands in Alaska, supra* note 43, at Attachment 1, p. 3.

[45] General permits, such as Nationwide General Permits are authorizations issued by the Corps for minor activities that the Corps has determined would have minimal impacts individually and cumulatively. These general permits have strict acreage limitations, and are typically well under one acre.

[46] *Alaska Wetlands Initiative Summary Report,* Table 1 (EPA et al., May 13, 1994), *available at* http://www.epa.gov/owow/wetlands/pdf/alask.pdf.

[47] Alaska District Regulatory Guidance Letter, RGL ID No. 09-01 at 8 (U.S. Army Corps of Engineers Alaska District, 2009) ("Alaska RGL").

[48] *Id.* at Appendix B. "High functioning wetlands" include those that "are undisturbed and contain ecological attributes that are difficult or impossible to replace within a human lifetime, if at all. . . . The position of the wetland in the landscape plays an integral role in overall watershed health." *Id.* at Appendix A, p. 3. They also include those where "[s]pawning areas are present (aquatic vegetation and/or gravel beds)." *Id.* at Appendix A, p. 6. The headwaters wetlands in the Koktuli and Upper Talarik watersheds fit these descriptions, as the subsequent section indicates.

Accordingly, our assessment of potential compensatory mitigation measures within the Bristol Bay watershed is based on the understanding that such measures would be required for hardrock mining projects that would impact anadromous fish streams and adjacent wetlands, such as those that are documented by PLP in its Environmental Baseline Document (EBD).

The Importance and Unique Ecological Functions of Headwaters Streams

Because compensatory mitigation is aimed at replacing lost aquatic functions, it is important to understand the specific functions that are performed by the headwaters streams and wetlands that would be lost if the Pebble Mine were permitted.

Headwater streams, which dominate the region surrounding the Pebble deposit, are defined as low order and intermittent streams at the fringes of watershed boundaries.[49] Although they may compose almost 80% of total stream length in many drainage networks,[50] they are often unmapped and overlooked due to their small size and sometimes intermittent flow.[51] In the North Fork and South Fork Koktuli Rivers and Upper Talarik Creek watersheds, headwater streams comprise more than twice the stream kilometers of mainstem habitat.[52] Because headwater and intermittent streams vary widely in physical, chemical, and biological characteristics, they provide varied and abundant habitats crucial to maintenance of diverse aquatic ecosystem function downstream.[53] Headwaters may be influenced by groundwater or subsurface (hyporheic) flow and/or variable shade conditions, producing variable water temperatures often providing warm refuges during winter and cool refuges during summer.[54] Due to inputs of organic matter, headwater streams determine downstream nutrient dynamics.[55] Many primary and secondary producers (*e.g.*, algae and aquatic macroinvertebrates) are unique to headwater ecosystems,[56] and may be adapted to freezing and intermittent flow conditions.[57]

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[49] Meyer, J.L., D.L Strayer, J.B. Wallace, S.L. Eggert, G.S. Helfman, and N.E. Leonard. 2007. The contribution of headwater streams to biodiversity in river networks. Journal of the American Water Resources Association 43(1): 86-103; Allan, J.D. and M.M. Castillo. 2007; STREAM ECOLOGY: STRUCTURE AND FUNCTION OF RUNNING WATERS. 2nd Ed. Springer. Dordrecht, The Netherlands. 436 pp.

[50] Richardson, J.S. and R.J. Danehy. 2007. A synthesis of the ecology of headwater streams and their riparian zones in temperate forests. Forest Science 53(2): 131-147.

[51] Meyer, J.L. and J.B. Wallace. 2001. Lost linkages and lotic ecology: Rediscovering small streams. In ECOLOGY: ACHIEVEMENT AND CHALLENGE. M.C. Press, N.J. Huntly, and S. Levin (Eds.). Blackwell Science, Malden, MA, pp. 295-317.

[52] 746 headwater km and 306 mainstem km. Personal communication, Marcus Geist, The Nature Conservancy (March 15, 2012).

[53] Meyer, J.L., et al. 2007, *supra* note 49; Wipfli, M.S., J.S. Richardson, and R.J. Naiman. 2007. Ecological linkages between headwaters and downstream ecosystems: Transport of organic matter, invertebrates, and wood down headwater channels. Journal of the American Water Resources Association 43(1): 72-85; Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The River Continuum Concept. Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137.

[54] Power, G., R.S. Brown, and J.G. Imhof. 1999. Groundwater and fish – insights from North America. Hydrological Processes 13: 401-422.

[55] Richardson, J.S., R.E. Bilby, and C.A. Bondar. 2005. Organic matter dynamics in small streams of the Pacific Northwest. Journal of the American Water Resources Association 41: 921-934.

[56] Progar, R.A. and A.R. Moldenke. 2002. Insect production from temporary and perennially flowing headwater: streams in western Oregon. Journal of Freshwater Ecology 17: 391-407.

The diversity and abundance of headwater species additionally provide source populations for colonization of downstream habitat as well as prey for downstream invertebrates and fish species.[58]

Because they provide refuge from predators and competitors, rich feeding grounds, and thermal refuge, fish species often exploit low order and ephemeral streams as either residents (*e.g.*, sculpin) or migrants (*e.g.*, salmonids).[59] Salmonids may use headwater streams as rearing (*e.g.*, coho, Chinook),[60] and spawning (*e.g.*, chum) habitat.[61] In a survey of 105 low-gradient, headwater streams in the Nushagak and Kvichak drainages, 96% of streams supported resident fish, and 75% of streams supported anadromous salmon species.[62] Headwater streams can also be important habitat for amphibians, birds, mammals, and other biota.[63] Headwater and intermittent streams are sites of enormous biological diversity, hosting hundreds to thousands of species.[64]

Mitigating impacts of a large-scale hardrock mine in the Bristol Bay watershed

Delineating the Watershed

The Corps has some flexibility in defining the scale of the watershed for compensatory mitigation purposes, but it is important that the scale "*not be larger than is appropriate to ensure that the aquatic resources provided through compensation activities will effectively compensate for adverse environmental impacts resulting from activities authorized by [Corps] permits.*"[65] For example, compensatory mitigation projects "*should be located where [they are] most likely to successfully replace lost functions and services . . . .*"[66]

The most appropriate watershed scale for purposes of compensating for unavoidable project impacts resulting from permitted discharges within the North Fork and South Fork Koktuli Rivers and/or Upper Talarik Creek drainages would be those same drainages. This scale is most

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[57] Irons, J.G., L.K. Miller, and M.W. Oswood. 1993. Ecological adaptations of aquatic macroinvertebrates to overwintering in interior Alaska (U.S.) subarctic streams. Canadian Journal of Zoology 71: 98-108.
[58] Wipfli, M.S. and D.P. Gregovich. 2002. Export of invertebrates and detritus from fishless headwater streams in southeastern Alaska: Implications for downstream salmonid production. Freshwater Biology 47: 957-969.
[59] Meyer, J.L., et al. 2007, *supra* note 49.
[60] Brown, T.G. and G.F. Hartman. 1988. Contribution of seasonally flooded lands and minor tributaries to the production of coho salmon in Carnation Creek, British Columbia. Transactions of the American Fisheries Society 117: 546-551; Wigington, P.J., J.L. Ebersole, M.E. Colvin, S.G. Leibowitz, B. Miller, B. Hansen, H. Lavigne, D. White, J.P. Baker, M.R. Church, J.R. Brooks, M.A. Cairns, and J.E. Compton. 2006. Coho salmon dependence on intermittent streams. Frontiers in Ecology and the Environment 4: 513-518.
[61] Meyer, J.L., et al. 2007, *supra* note 49.
[62] Woody, C.A. and S.L. O'Neal. 2010. Fish surveys in headwater streams of the Nushagak and Kvichak river drainages, Bristol Bay, Alaska 2008-2010. Prepared for The Nature Conservancy. 48 pp.
[63] Meyer, J.L., et al. 2007, *supra* note 49.
[64] *Id.*
[65] 40 C.F.R. § 230.93(c)(4).
[66] *Id.* § 230.93(b)(1); *see also id.* § 230.93(c)(1) (Corps must use a watershed approach to compensatory mitigation where appropriate and practicable).

appropriate because it would offer the greatest likelihood that compensatory mitigation measures would replace the specific suite of aquatic resource functions lost due to permitted discharges in those drainages. Mitigation projects within these specific drainages would also offer the only opportunity to protect habitat for the particular salmon stocks that originate in these drainages. This is an important consideration in light of the documented importance of the diversity of salmon stocks to the stability of the overall Bristol Bay salmon fishery – the so-called "portfolio effect."[67]

Where there are no reasonable or practicable measures that could be undertaken in these watersheds, it would be appropriate for the Corps and/or the EPA to require compensatory mitigation within the closest "hydrologic units" as defined by the U.S. Geological Survey, in this case the Mulchatna River and Lake Iliamna watersheds.[68] The South Fork and North Fork Koktuli Rivers flow into the Mulchatna River, and Upper Talarik Creek flows into Lake Iliamna; thus, these two watersheds would offer a somewhat broader geographic area within which to identify mitigation sites while remaining close to the site of impact.

The EPA assessed a broader geographic area in its draft BBWA – the Nushagak and Kvichak River watersheds, including navigable and non-navigable tributaries – because that is where large-scale hardrock mining projects are most likely to occur. However, the geographic scope of the draft BBWA, focusing on known locations of large-scale mineral deposits, is not, and should not be inferred to represent, the appropriate watershed scale for compensatory mitigation for discharges from the proposed Pebble Mine or any other permitted discharge in one of the several drainages that flow into Bristol Bay. The Nushagak and Kvichak River systems drain a large area, about as large as the State of West Virginia. Defining the watershed scale this broadly (or even more broadly as the entire Bristol Bay watershed) likely would fail to meet the fundamental requirement of the Mitigation Rule that the aquatic resources provided through compensation must effectively compensate for the adverse environmental impacts of the permitted discharge. The genetic differences between individual salmon stocks in various drainages, and the importance of this genetic diversity to the overall stability of the Bristol Bay salmon fishery, undermine the value of mitigation measures designed to protect aquatic resources in a drainage other than the site of impact.

For example, the California Central Valley is also approximately the size of the State of West Virginia and, like the draft BBWA study area, is drained by two major rivers, in this case the Sacramento and San Joaquin, which flow into San Francisco Bay. Like the portion of the larger Bristol Bay watershed where the EPA focused its assessment, the California Central Valley is not a single watershed, nor is it made up of simply the Sacramento and San Joaquin River watersheds. Instead, the U.S. National Marine Fisheries Service identifies 28 major watersheds in the Central Valley, as well as geologic and genetic differences that would contraindicate

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[67] *See, e.g.,* Schindler, D.E., R. Hilborn, B. Chasco, C.P. Boatright, T.P. Quinn, L.A. Rogers, and M.S. Webster. 2010. Population diversity and the portfolio effect in an exploited species. Nature 465: 609-612.

[68] *See http://cfpub.epa.gov/surf/huc.cfm?huc_code=19030302* (Mulchatna River watershed) and *http://cfpub.epa.gov/surf/huc.cfm?huc_code=19030206* (Lake Iliamna watershed). The USGS hydrologic units are identified in the 2008 Mitigation Rule as an appropriate basis for determining the service area of an in-lieu fee provider. *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule*, 73 FED. REG. 19594, 19654 (April 10, 2008). Thus, it seems reasonable to use them to define the watershed scale for compensatory mitigation purposes where no practicable mitigation options exist in the specific drainages affected by the permitted discharges.

allowing a permittee to compensate for anadromous fishery impacts in one of these watersheds with measures in another Central Valley watershed.[69]

An even more expansive view of the relevant watershed is cited in a white paper prepared by HDR Inc., for Northern Dynasty Minerals, Inc. (NDM) that endorses a proposal by The Conservation Fund to divide its in-lieu fee provider service area, which is the entire State of Alaska, into five large geographic service areas:

> *"Under that program, the Bristol Bay watershed, the Kuskokwim River watershed, Kodiak Island, and the Alaska Peninsula are grouped into one service area called Southwest Alaska. The regional scale of this 'watershed' makes sense because development projects are scattered across an extensive and sparsely populated area, the ecological resources are similar, and mitigation opportunities can be clustered for greater ecological benefit."*[70]

This justification for a broad watershed definition may be reasonable in the context of small development projects scattered across an extensive area, which is how in-lieu fee programs are generally used in Alaska, but it is not reasonable in the context of a very large project like the proposed Pebble Mine with enormous impacts on unique aquatic resources at a specific site. The Conservation Fund proposal reflects a provision of the Mitigation Rule that allows an in-lieu fee provider to define its service area (the area within which it is authorized to provide compensatory mitigation) based on a "*watershed, ecoregion, physiographic province, and/or other geographic area . . . .*"[71]

Although the Corps has accepted this particular in-lieu fee provider's broad delineation of watersheds within the state, this should not diminish the Corps' responsibility under the Mitigation Rule to ensure that the watershed scale is defined appropriately for each specific compensatory mitigation proposal.[72] A mitigation project in the Kuskokwim River watershed or on Kodiak Island clearly would not be capable of replacing the particular ecological functions provided by the headwaters of the Koktuli River and Upper Talarik Creek drainages. Accordingly, because the regulations require a more precise focus, this document assesses the potential for mitigation to be implemented within the specific watersheds where the impacts would occur or within the closest USGS hydrologic units.

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[69] National Marine Fisheries Service. 2009. Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead. Sacramento Protected Resources Division. Appendix A. Central Valley Watershed Profiles. October 2009. 262 pp.

[70] Wrobel, C., J. Morton, M. Witter, and J. Anderson. Undated. White Paper No. 5: Wetlands Mitigation. *See also* Public Notice of Application for In Lieu Fee Sponsorship (Army Corps Alaska District, Sept. 29, 2011), *available at* *http://www.poa.usace.army.mil/reg/PN_Scanned/2011%20September/POA-2010-132.pdf*.

[71] 40 C.F.R. § 230.98(d)(6)(ii)(A).

[72] *See id.* § 230.93(c)(4).

Estimating the magnitude of impacts for which compensatory mitigation would be required

In assessing the potential opportunities and effectiveness of compensatory mitigation measures that could be implemented within the affected watersheds, this document assumes that the discharges associated with a potential hardrock mine are unavoidable and would not violate State water quality standards or jeopardize federally listed threatened or endangered species. However, the Corps or the EPA may, in fact, determine that there are less damaging alternatives that are practicable, including alternative ore deposits that could be acquired, utilized, or managed in order to achieve the basic purpose of the proposed mine (extraction of copper and associated minerals).[73] These agencies may also find that a large-scale hardrock mine in this area could result in unacceptable risks to water quality, but as stated above, this document focuses on mitigating impacts to wetland and aquatic habitats.

In its Environmental Baseline Document (EBD), PLP reported that roughly 33% of its "mine mapping area" was found to be wetlands and aquatic areas.[74] PLP did not quantify these acreages with regard to any potential mine project footprint. The wetland maps in the EBD show that the low-lying areas that overlie the known Pebble ore deposit and the site of a likely tailings storage facility contain a high percentage of wetland and aquatic sites, but these maps have not been verified. This document therefore uses PLP's 33% average to estimate the acreage that might require compensatory mitigation, recognizing that these may be substantial underestimates for the proposed Pebble Mine as described in Ghaffari et al. (2011).[75]

Ghaffari et al. (2011) shows an initial mining footprint that would cover approximately 9400 acres for a 25-year mining project.[76] Using PLP's overall estimate of wetland and aquatic areas within its mine mapping area, more than 3000 acres of wetlands, streams, and open-water areas would be lost and subject to regulatory requirements for compensatory mitigation (see Figures 1 and 2). This 3000-acre figure is used herein to assess the availability of appropriate and practicable measures to offset potential project impacts, recognizing that the actual impacts may be much larger, particularly if the mine operates for 45 years or more as Pebble Mine sponsor Northern Dynasty Minerals suggests.[77] Were the sponsors of the proposed Pebble Mine to apply for a permit, the environmental analysis required under the National Environmental Policy Act

[73] For a discussion of alternative ore deposits, as well as other issues concerning CWA compliance while mining the Pebble ore deposit, *see* Riley, William M. and Thomas G. Yocom. 2011. Mining the Pebble deposit: Issues of 404 compliance and unacceptable environmental impacts. Report prepared for the Bristol Bay Native Corporation and Trout Unlimited. December 2011. 55 pages, plus figures and tables.
[74] See Pebble Limited Partnership, Environmental Baseline Document, Chapter 14 (2012), *available at* http://www.pebbleresearch.com/
[75] Ghaffari, H., R. S. Morrison, M. A., deRuijeter , A. Živković, T. Hantelmann, D. Ramsey, S. Cowie. 2011. Preliminary Assessment of the Pebble Project, Southwest Alaska. Prepared for Northern Dynasty Minerals Ltd., by WARDROP (a Tetra Tech Company). Vancouver, British Columbia. Document 1056140100-REP-R0001-00. 579 pp.
[76] Riley, et al. 2011, *supra* note 73. This footprint is similar to that of the hypothetical mine evaluated in the EPA's draft BBWA.
[77] See *http://www.northerndynastyminerals.com/i/pdf/ndm/NDM_Presentation_Sept2012.pdf* (last visited Sept. 25, 2012).

(NEPA) would necessarily include reasonably-foreseeable related actions, including this 45-year "reference case," and the larger 75+ year alternative described in Ghaffari et al. (2011).

Under the 2008 Mitigation Rule, the appropriate amount of compensatory mitigation would be determined, in the first instance, through a Corps-approved functional or conditional assessment to quantify the aquatic resource functions that would be lost if the Pebble Mine were built. This assessment would focus on the specific and unique functions performed by the headwaters streams and wetlands in the area of the Pebble deposit, as described earlier. In the absence of such an assessment, the proper compensation ratio for the headwaters streams and wetlands destroyed by discharges of dredged or fill material from mining the Pebble Deposit would be at least 2:1 if the mitigation method is restoration or enhancement or at least 3:1 if the compensatory mitigation method is preservation.[78] This translates to at least 6000 acres of compensatory mitigation for restoration or enhancement and at least 9000 acres of compensatory mitigation for preservation.

Potential options for compensatory mitigation

In its white paper for NDM, HDR Inc. lists types of compensatory mitigation that might be available to offset impacts from one or more large-scale hardrock mines in the Bristol Bay watershed:

> *Compensatory mitigation for wetlands impacts could, for example, take the form of anadromous fish habitat restoration, property acquisition for conservation easements, water quality improvements, remediation of contaminated sites, biodiversity offsets, funding for research and education, or other options. There may be opportunities for development organizations to join with local tribal governments and non-governmental organizations to create wetland mitigation banks or endowment funds to manage fish and wildlife, water quality, and preservation of undeveloped natural resources for generations to come.*[79]

These various measures can, on a case-by-case basis, offset project impacts, though habitat restoration and enhancement are most effective at offsetting direct permanent losses of wetland and aquatic habitats. Preservation of existing habitat, even when there is clear evidence that such habitat would be otherwise under immediate threat for destruction or degradation, does not offset project impacts or result in overall ecological improvement. Nevertheless, there is greater flexibility to mitigate through preservation and other in-lieu fee mechanisms in Alaska than in other parts of the United States where opportunities for restoration and enhancement of degraded habitats are far greater.

Using the categories of compensatory mitigation described in the 2008 Mitigation Rule and the 2009 Alaska Corps District guidance pursuant to that rule, this document examines the opportunities for mitigating impacts of one or more large-scale hardrock mines within the

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[78] Alaska RGL at Appendix B.
[79] Wrobel, C., et al., *supra* note 70.

Mulchatna River and Lake Iliamna watersheds, including some of the actions suggested by HDR Inc., above.[80]

Mitigation Banks

The use of mitigation banks is encouraged under the 2008 Mitigation Rule as a less risky and more effective (than permittee-responsible mitigation) means of offsetting the impacts associated with Section 404 permits.[81] Mitigation banks are supported where they are available and appropriate. The Corps, Alaska District, lists four approved mitigation banks, but since none of these serve the Bristol Bay region[82] they would not be available or appropriate for offsetting impacts to wetland and aquatic areas within the watersheds of Bristol Bay.

PLP has identified establishing a new mitigation bank as a possible compensatory mitigation measure. The Mitigation Rule provides extensive and detailed rules for establishing a mitigation bank, with which PLP would have to comply.[83] Most significantly, before a mitigation bank can release credits as compensatory mitigation for permitted impacts, it must have in place an approved instrument, including a mitigation plan, appropriate real estate and financial assurances, and have achieved "*specific milestones associated with the mitigation bank site's protection and development . . . .*"[84]

A problem with this option is the general lack of appropriate restoration, enhancement, or preservation sites within the watershed. The Mulchatna River and Lake Iliamna watersheds are largely pristine and unaltered by human activities. There appear to be no degraded habitat areas of similar function and adequate size within the Upper Talarik Creek or Koktuli River drainages, or within the greater Mulchatna River or Lake Iliamna watersheds, that could be restored or enhanced. Nor are there appropriate preservation sites within these drainages – *i.e.* sites that perform similar aquatic functions, that are of the appropriate acreage, and that are under threat of development – other than the Pebble site itself.

There are some scattered degraded sites within the more-distant Lower Nushagak watershed[85] that could benefit from restoration, but it is unlikely that these sites could provide the acreage or ecological function that would be lost at the Pebble site. Some of these sites, moreover, are old mines that would require resolution of liability and contamination issues before they could serve as mitigation sites.[86] Preservation options are also limited in the Lower Nushagak watershed

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[80] Some of the ideas described in the HDR white paper are not addressed herein because they would not offset the habitat losses caused by the proposed Pebble Mine and therefore would not be suitable as primary compensatory mitigation. These include rehabilitating chum and coho stocks in the southeastern Bering Sea through measures like mist incubation, rehabilitating sockeye stocks through lake fertilization, and funding research efforts or joint ventures.
[81] *See* 40 C.F.R. § 230.93(b)(2).
[82] *See http://www.poa.usace.army.mil/reg/links/Alaska%20District%20Approved%20Mitigation%20Banks.pdf* (last visited Sept. 25, 2012).
[83] *See generally* 40 C.F.R. § 230.98.
[84] 40 C.F.R. § 230.93(b)(2).
[85] *See http://cfpub.epa.gov/surf/huc.cfm?huc_code=19030303* (last visited Sept. 25, 2012). The Lower Nushagak hydrologic unit as defined by USGS does not coincide with the physical boundaries of the lower Nushagak River watershed, as it separates the Wood River drainage into a separate hydrologic unit.
[86] One example is the Red Top Mine on Marsh Mountain just east of Aleknagik, which produced about 120 flasks of

because of the sheer number of acres that would be required, and the difficulty of finding sites to offset the loss of pristine headwaters streams and wetlands and their unique ecological functions.

An additional challenge is that ownership of the land in the region is mixed amongst state and federal ownership, as well as private lands and Native allotments. Even though public lands can provide mitigation options in appropriate circumstances, credit for such mitigation is given only for "*aquatic resource functions provided by the compensatory mitigation project, over and above those provided by public programs already planned or in place*,"[87] and preservation is an acceptable mitigation method only where the mitigation site is under threat.[88] Further, preservation in this context, especially downstream from the proposed Pebble project if that were the choice, would be effective only if the headwaters of the preservation area were not degraded. These limitations would preclude most sites of adequate acreage and similar aquatic function from serving as acceptable mitigation sites for the proposed Pebble project.

In-Lieu Fee Programs

In areas where the mitigation bank option is not feasible, use of in-lieu fee credits is generally preferred over permittee-responsible mitigation, for the same reasons that mitigation banks are preferred.[89] As with mitigation bank credits, however, the use of in-lieu fee credits is allowed only where the in-lieu fee program sponsor "*has the appropriate number and resource type of credits available . . . .*"[90]

The Alaska District lists three in-lieu fee sponsors,[91] one of which (The Conservation Fund) is actively seeking to purchase conservation easements within the Bristol Bay region as part of its Southwest Alaska Salmon Habitat Initiative.[92] Presumably, if a proposal to mine the Pebble deposit was determined by the Corps to result in unavoidable impacts to salmon habitat, one potential mitigation avenue might be the use of such an in-lieu fee program, although the magnitude of potential project impacts might preclude such a mechanism. No efforts to purchase conservation easements within the Mulchatna River or Iliamna Lake watersheds were identified during the preparation of this document.

According to The Conservation Fund, there are "*[o]pportunities for compensatory mitigation through wetlands preservation [such as] the purchase of strategic in-holdings in Wood-Tikchik*

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mercury through 1970 and has apparently not been in production since then. *See* Grybeck, Donald J., Alaska Resource Data File, New and Revised Records Version 1.5 at 564-566 (U.S. Geological Survey, 2008), *available at* *http://ardf.wr.usgs.gov/ardf_data/1225.pdf* (last visited Sept. 17, 2012). Although the acres of impact are not identified in the Alaska Resource Data File (ARDF), it can be inferred from the 10,000 feet of surface dozer trenching and about 1,480 feet of underground workings described in the ARDF that the acreage is fairly small. The ARDF description of the mine's geology gives no indication of any aquatic resources similar to those at the Pebble site.

[87] *Id.* § 230.93(a)(3).

[88] *Id.* § 230.93(h)(1)(4).

[89] *Id.* § 230.93(b)(3).

[90] *Id.*

[91] *See http://www.poa.usace.army.mil/reg/links/Alaska%20District%20In-lieu%20Fee%20Sponsors.pdf* (last visited Sept. 25, 2012)

[92] *See http://www.conservationfund.org/alaska_hawaii/alaska/southwest_ak_salmon*. This effort is aided, in part, by donations from the Bristol Bay Native Corporation.

State Park, Togiak, Becharof, Alaska Peninsula Izembek and Kodiak National Wildlife Refuges, Afognak and Shuyak Island State Parks, Katmai and Lake Clark National Park and other state and federal conservation units."[93] These locations, however, are far from the impact site, and only the Wood-Tikchik State Park reaches, though barely, into the Lower Nushagak hydrologic unit as defined by USGS. According to the most recent land use plan for the Wood-Tikchik State Park, private inholdings within the park are limited to 27 Native allotments (which are generally very small – 80 or 160 acres) that are not already subject to a conservation easement, and 9 other private inholdings that are also quite small.[94] It is unlikely that many of these contain wetlands of any significance. Regardless, accepting preservation in these distant locations as mitigation for impacts in the Mulchatna River and Lake Iliamna watersheds would be inconsistent with the Mitigation Rule emphasis on providing ecological benefits close to the site of impact.

Permittee-Responsible Compensatory Mitigation

For permittee-responsible compensatory mitigation, the Mitigation Rule provides the following order of priorities: a watershed approach is preferred, followed by on-site, in-kind mitigation, with off-site, out-of-kind mitigation considered as a last resort.

Fish Passage: Road Crossings

One potential measure that could be considered compatible with a watershed approach is to provide fish passage across man-made features such as road crossings. Virtually all streams near the Pebble deposit support anadromous and resident fish.[95] Because stream crossings can impact spawning, rearing,[96] and refuge habitats,[97] they can reduce genetic diversity,[98] thereby reducing long-term sustainability of salmon populations.[99] Fish passage is a problem commonly

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[93] The Conservation Fund, A Prospectus to Establish and Administer the Alaska Statewide In-Lieu Fee Compensatory Mitigation Program at 12 (July 2011), *available at* http://www.poa.usace.army.mil/reg/PN_Scanned/2011%20September/POA-2010-132.pdf.

[94] Wood-Tikchik State Park Management Plan at 2-2, 7-11 (map) (Alaska Dep't of Natural Resources, Div. Parks & Outdoor Rec'n, Oct. 2002), *available at* http://dnr.alaska.gov/parks/plans/woodt/wtplan4mb.pdf (last visited Sept. 18, 2012).

[95] Woody, C.A. and S.L. O'Neal. 2010. Fish surveys in headwater streams of the Nushagak and Kvichak river drainages, Bristol Bay, Alaska 2008-2010. Prepared for The Nature Conservancy. 48 pp; ADFG. 2012; Anadromous waters catalog (Alaska Dep't of Fish & Game), *available at* http://www.sf.adfg.state.ak.us/SARR/awc/ (last visited September 14, 2012).

[96] Davis, J.C. and G.A. Davis. 2011. The influence of stream-crossing structures on the distribution of rearing juvenile Pacific salmon. Journal of the North American Benthological Society 30(4): 1117-1128; Sheer, M.B. and E.A. Steel. 2006. Lost watersheds: Barriers, aquatic habitat connectivity, and salmon persistence in the Willamette and lower Columbia River basins. Transactions of the American Fisheries Society, 135(6): 1654-1669.

[97] Price, D.M., T. Quinn, and R.J. Barnard. 2011. Fish passage effectiveness of recently constructed road crossing culverts in the Puget Sound region of Washington State. North American Journal of Fisheries Management 30: 1110-1125.

[98] Neville, H., J. Dunham, A. Rosenberger, J. Umek, and B. Nelson. 2009. Influences of wildfire, habitat size, and connectivity on trout in headwater streams revealed by patterns of genetic diversity. Transactions of the American Fisheries Society 138: 1314-1327; Wofford, J.E.B., R.E. Gresswell, and M.E. Banks. 2005. Influence of barriers to movement on within-watershed genetic variation of coastal cutthroat trout. Ecological Applications 15: 628-637.

[99] Hilborn, R., T.P. Quinn, D.E. Schindler, and D.E. Rogers. 2003. Biocomplexity and fisheries sustainability. Proceedings of the National Academy of Sciences 100(11): 6564-6568; Schindler, D.E., et al. 2010, *supra* note 67.

associated with declines in salmon and other fish populations throughout the United States,[100] including Alaska.[101] Presumably one possible compensatory mitigation measure that could be proposed to offset impacts from a large-scale hardrock mining project would be to remove and replace crossings at other non-project sites that serve as barriers to fishes with crossings that improve fish passage. Although such actions would not offset the direct losses of thousands of acres of wetlands and water bodies or losses of stream miles, they could provide improved habitat access by anadromous fishes.

That said, even the sponsors of the proposed Pebble Mine may find ensuring unimpeded fish passage at its own proposed road crossings to be challenging for its 86-mile proposed road between the Pebble ore deposit and Cook Inlet, due to the high gradient terrain surrounding much of the potential road corridor.[102] The road will require at least 80 stream crossings of streams ranging from small headwaters to large perennial rivers such as the Iliamna and Newhalen rivers.[103] All fish passage sites will require regular maintenance, and the construction of a road may open access to additional spur road construction. So although some efforts to maintain or improve fish passage may prove successful, the associated road construction may serve to enable impacts that are adverse.

Determining whether a fish passage project is a suitable mitigation measure would demand, first, determining whether there is already a party responsible for maintaining fish passage through, for example, repairing and replacing road crossings; if so, then it would be inappropriate for another party to use such a project for mitigation credit. In addition, quantifying the compensatory mitigation credit to assign to any particular fish passage improvement or series of improvements would require assessments of the existing conditions above and below the barrier, as well as the potential improvement in habitat functions that would result in upstream habitats following the improvement. Where historical information is available for habitat functions prior to the placement of the barrier, it should also be considered. Where fish passage is essentially blocked, and where habitat above the blockage is suitable, providing permanent improvement of fish passage/access would constitute forms of restoration and/or enhancement for which compensatory mitigation credit could be determined appropriate.

Such improvements would, however, as with other forms of compensatory mitigation, be permanent, and where long-term maintenance is anticipated it would need to be included in perpetuity.

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[100] Nehlsen, W., J.E. Williams, and J.E. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2): 4-21; Bates, K., B. Barnard, B. Heiner, J.P. Klavis, and P.D. Powers. 2003. Design of road culverts for fish passage. Washington Department of Fish and Wildlife, Olympia. 112 pp.
[101] ADFG. 2012. Fish Passage Improvement Program, *available at* http://www.adfg.alaska.gov/index.cfm?adfg=fishpassage.projects (last visited September 15, 2012).
[102] Ghaffari, H., et al. 2011, *supra* note 75.
[103] PND Engineers, Inc. 2007. Iliamna regional transportation corridor analysis. Prepared for Alaska Department of Transportation and Public Facilities. 148 pp.

Fish Passage: Beaver Dams

In PLP's EBD, beaver dams of ≥0.25 m and higher are listed as potential temporary barriers.[104] Although people may perceive beaver dams as impediments to fish passage, studies supporting this perception are generally speculative[105] and no study has demonstrated adverse population impacts to fish from beaver dams. Beaver dams are semipermeable and may limit fish movement temporarily during low stream flows[106] but generally do not constitute significant barriers to salmonid migration.[107] When beaver dams do present barriers they are generally short-lived, as dams are overtopped or blown out by storm surges.[108]

Pacific salmon and other fish species are commonly found above beaver dams. In southeast Alaska, coho salmon were documented upstream of all surveyed beaver dams, including a 2-meter high beaver dam; highest coho densities were documented in streams with beaver.[109] Both adult and juvenile sockeye salmon, coho salmon, steelhead, cutthroat, and char are documented upstream of beaver dams.[110] Chinook juveniles have been documented above beaver dams;[111] some anecdotal evidence suggests that beaver dams can be an obstacle to upstream chum salmon movement.[112]

A recent meta-analysis of the impacts of beaver on freshwater fish indicates that beaver have a positive impact on coho, Chinook, Dolly Varden, rainbow trout, sockeye salmon, and

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[104] PLP EBD Appendix B Chapter 15.

[105] Kemp, P.S., et al. 2012. Qualitative and quantitative effects of reintroduced beavers on stream fish. Fish and Fisheries. 13:158-181.

[106] Pollock M.M., M. Heim, D. Werner. 2003. Hydrologic and geomorphic effects of beaver dams and their influence on fishes. In Gregory, S.V., K. Boyer, A. Gurnell (eds.), THE ECOLOGY AND MANAGEMENT OF WOOD IN WORLD RIVERS, American Fisheries Society: Bethesda, MD; 213–233.

[107] *Id.;* Rupp, R. S. 1954. Beaver-trout relationships in the headwaters of Sunkhaze Stream, Maine. Transactions of the American Fisheries Society 84:75–85; Bryant, M. D. 1983. The role of beaver dams as coho salmon habitat in southeast Alaska streams. Pages 183–192 *in* J. M. Walton and D. B. Houston (eds.), PROCEEDINGS OF THE OLYMPIC WILD FISH CONFERENCE. Olympic Wild Fish Conference, Port Angeles, Washington; Gard, R. 1961. Effects of beaver on trout in Sagehen Creek, California. Journal of Wildlife Management 25 (3): 221–242. *doi:10.2307/3797848. JSTOR 3797848.*

[108] Kemp, P.S., et al. 2012, *supra* note 105; Leidholt-Bruner, K., D.E. Hibbs, and W. C. McComb. 1992. Beaver Dam Locations and Their Effects on Distribution and Abundance of Coho Salmon Fry in Two Coastal Oregon Streams. Northwest Science. Retrieved 2011-04-16.

[109] Bryant, M.D. 1984. The Role of Beaver Dams as Coho Salmon Habitat in southeast Alaska Streams. In Walton, J.M. and D.B. Houston (eds.), PROCEEDING, OLYMPIC WILD FISH CONFERENCES (Port Angeles, Washington: Peninsula College, Fisheries Technology program): 183–192.

[110] *Id.;* Swales, S., F. Caron, J. R. Irvine, and C. D. Levings. 1988. Overwintering habitats of coho salmon (*Oncorhynchus kisutch*) and other juvenile salmonids in the Keogh River system, British Columbia. Canadian Journal of Zoology 66:254–261; Murphy, M. L., J. Heifetz, J. F. Thedinga, S. W. Johnson, and K. V. Koski. 1989. Habitat utilization by juvenile Pacific salmon (*Oncorhynchus*) in the glacial Taku River, southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences 46:1677–1685; Pollock, M.M., M. Heim, and D. Werner. 2003. Hydrologic and geomorphic effects of beaver dams and their influence on fishes. In THE ECOLOGY AND MANAGEMENT OF WOOD IN WORLD RIVERS, Gregory, S.V., K. Boyer, and A. Gurnell (eds). American Fisheries Society: Bethesda, MD; 213–233.

[111] Rosenau, M. and M. Angelo. 1999. Freshwater Habitat. Pacific Fisheries Resource Conservation Council, Vancouver, B.C.

[112] Pollock *et al.* 2003, *supra* note 106.

steelhead.[113] Most frequently cited benefits in this study were: increased habitat heterogeneity, rearing and overwintering habitat, flow refuge and invertebrate production. Most frequently cited negative impacts were impeded fish movement, siltation of spawning habitat and low O_2 in ponds, however, the majority of studies citing negative impacts were speculative versus data driven.[114] The conclusion that should be drawn from these studies is that removing beaver dams to improve fish passage would not be an appropriate compensatory mitigation measure for the proposed Pebble mine.

Fish Passes

Thousands of fish passes have been installed worldwide in efforts to reverse continued human-caused extirpation or extinction of fish species.[115] Every fish pass represents a singular experiment subject to unique environmental and biological conditions. Most North American fish passes focus on facilitating upstream passage of a single life stage and one or a few species (*e.g.* adult salmon), although the number of fish successfully passing relative to the number that attempt to pass is rarely monitored.[116] Even with this limited focus, fish passes still delay or prevent upstream passage of both target and non-target species,[117] which can cause delayed mortality or reduced spawning success.[118] Combined with the fact that fish passes require constant maintenance, upkeep, and repair,[119] their ability to mitigate for long-term or perpetual development impacts is untenable.

To emulate or replace lost wetland ecosystem function, fish passes must allow both upstream and downstream movement of the full suite of fish species and life stages within the watershed of interest. Scientific evidence indicating fish passes can attain this goal is lacking.

Hatcheries

Although there are no proposals to provide hatchery production to offset fishery losses, it is likely that such proposals would not be viewed favorably. According to the Northwest Fisheries Science Center (NOAA Fisheries), wild salmon populations have declined dramatically over the past several decades, "*despite, and perhaps sometimes because of, the contribution of hatcheries.*

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113 Kemp, P.S. et al. 2012, *supra* note 105.
114 *Id.*
115 Nehlsen, W. et al. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16:4-21; Sheer, M.B. and E.A. Steel. 2006. Lost watersheds: barriers, habitat connectivity, and salmon persistence in the Willamette and lower Columbia River basins. Transactions of the American Fisheries Society. 135:1654-1669.
116 Bunt, C.M. et al. 2012. Performance of fish passage structures at upstream barriers to migration. River Research and Applications. 28:457-478.
117 Roscoe, D.W. and S.G. Hinch. 2010. Effectiveness monitoring of fish passage facilities: historical trends, geographic patterns and future directions. Fish and Fisheries. 11:12-23; Bunt, C.M. et al. 2012, *supra* note 116; http://scholarworks.umass.edu/fishpassage_conference/2012/June6/33/.
118 Roscoe, D.W. et al. 2011. Fishway passage and post-passage mortality of up-river migrating sockeye salmon in the Seton River, British Columbia. River Research and Applications. 27:695-705.
119 Washington State Department of Transportation. SEPA letter dated May 11, 2009; O'Brien, T., T. Ryan, I. Stuart and S. Saddlier. 2010. Review of fishways in Victoria 1996–2009. Arthur Rylah Institute for Environmental Research Technical Report Series No. 216. Department of Sustainability and Environment, Heidelberg, Victoria; Washington Dept. of Fish and Wildlife. June 2, 2009. Hydraulic Project Approval. Fishway Structures in Freshwaters Statewide. Control No. 117192-1.

Many salmon stocks in Washington and Oregon are now listed as either threatened or endangered under the U.S. Endangered Species Act. With this decline has come an increased focus on the preservation of indigenous wild salmon stocks."[120] Remaining wild populations provide a better chance for long-term survival of salmon inasmuch as these populations have evolved in response to significant environmental changes over many thousands of years, and can be expected to do so in the future.

Hatchery-produced salmon lack the genetic diversity of wild salmon,[121] which is essential to the sustainability of salmon and prevention of fisheries collapses.[122] Inter-breeding between hatchery and wild fish consequently lowers survival and fitness of wild salmon.[123] Hatchery fish also compete with wild salmon for food and habitat in both freshwater and marine environments, and in some cases prey directly on wild salmon.[124] Despite billions of dollars spent to produce hundreds of thousands of hatchery salmon in the Pacific Northwest in an attempt to recover threatened and endangered salmon, stocks remain imperiled and indeed are further threatened by interactions with hatchery fish.[125]

Preservation of wild salmon has broad political support in Alaska. For example, Alaska's senior senator, Sen. Lisa Murkowski (R-AK), introduced legislation with Sen. Maria Cantwell (D-WA) in 2011 to create a public-private partnership focused on sustaining strong wild salmon populations.[126] According to Senator Murkowski, "Through the creation of a public/private partnership and grant program, it is my hope that that we can ensure that these salmon strongholds will continue to produce abundant wild salmon runs long into the future."

Conclusion

In spite of assertions made by sponsors of the proposed Pebble mine that mitigation measures would reduce and/or fully offset impacts of large-scale hardrock mining projects within the Bristol Bay watershed, there appear to be few, if any, measures that would be reasonable and practicable within the associated watersheds that could offset the enormous losses of headwaters wetland and aquatic habitats that would be destroyed by the proposed Pebble Mine. It is clear that the direct losses of habitat could be thousands of acres, and the means to offset such losses would require a multiple of that acreage figure under the 2008 Mitigation Rule.

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[120] *See* http://www.nwfsc.noaa.gov/resources/search_faq.cfm?faqmaincatid=3 (last visited Sept. 25, 2012).

[121] Christie, M.R., M.L. Marine, R.A. French, M.S. Blouin. 2011. Genetic adaptation to captivity can occur in a single generation. Proceedings of the National Academy of Science 109: 238-242; Fraser, D.J. 2008. How well can captive breeding programs conserve biodiversity? A review of salmonids. Evolutionary Applications 4: 535-586.

[122] Schindler, D.E., et al. 2010, *supra* note 67.

[123] Waples, R.S. 1991. Genetic interactions between hatchery and wild salmonids: Lessons from the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences 48: 124-133.

[124] Rand, P.S., B.A. Berejikian, T.N. Pearsons, and D.L.G. Noakes. 2012. Ecological interactions between wild and hatchery salmonids: An introduction to the special issue. Environmental Biology of Fishes 94: 1-6.

[125] Kostow, K. 2009. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries 19: 9-31.

[126] *See* Mark Yuasa, *Bill introduced by Senator Maria Cantwell would help boost wild salmon runs*, Seattle Times (Aug. 6, 2011), *available at* http://seattletimes.com/html/reeltimenorthwest/2015837836_bill_introduced_by_senator_mar.html (last visited Sept. 18, 2012) (discussing introduction of the Pacific Salmon Stronghold Conservation Act of 2011).

There are various potential means of offsetting unavoidable project impacts, including mitigation banks, in-lieu fee mechanisms, permittee-responsible mitigation projects, and preservation of existing, but threatened, habitat. These do not appear to be available or practicable within the Mulchatna River or Lake Iliamna watersheds. There are no mitigation banks that serve these watershed areas, nor any in-lieu fee projects there. Inasmuch as the habitats that would be destroyed in mining the Pebble deposit are pristine, there really are no known means of recreating such areas, and preserving such habitat elsewhere does little to offset permanent losses.

There may be some opportunities to restore degraded habitat at former mining sites, and opportunities to improve migratory fish passage across, around, or through man-made barriers, but such opportunities are 1) not likely to be plentiful enough to offset thousands of acres of mining-related losses, 2) not particularly effective at offsetting project impacts, and 3) likely to require maintenance in perpetuity.

In short, it does not appear to be reasonable or practicable to offset the impacts of mining the Pebble deposit through the use of compensatory mitigation within the Mulchatna River or Lake Iliamna watersheds. If this is so, then the post-project condition for plant and animal populations will certainly not be at a "state of higher ecological value" than the pre-project conditions, as envisioned by the 404(b)(1) Guidelines,[127] and the determination that the project would cause or contribute to significant degradation of the waters of the United States would be based solely on the otherwise unmitigated project impacts. Under these circumstances, a proposed mining project would not qualify for permitting under Section 404 of the Clean Water Act.

[127] *See* 40 C.F.R. § 230.75(d).

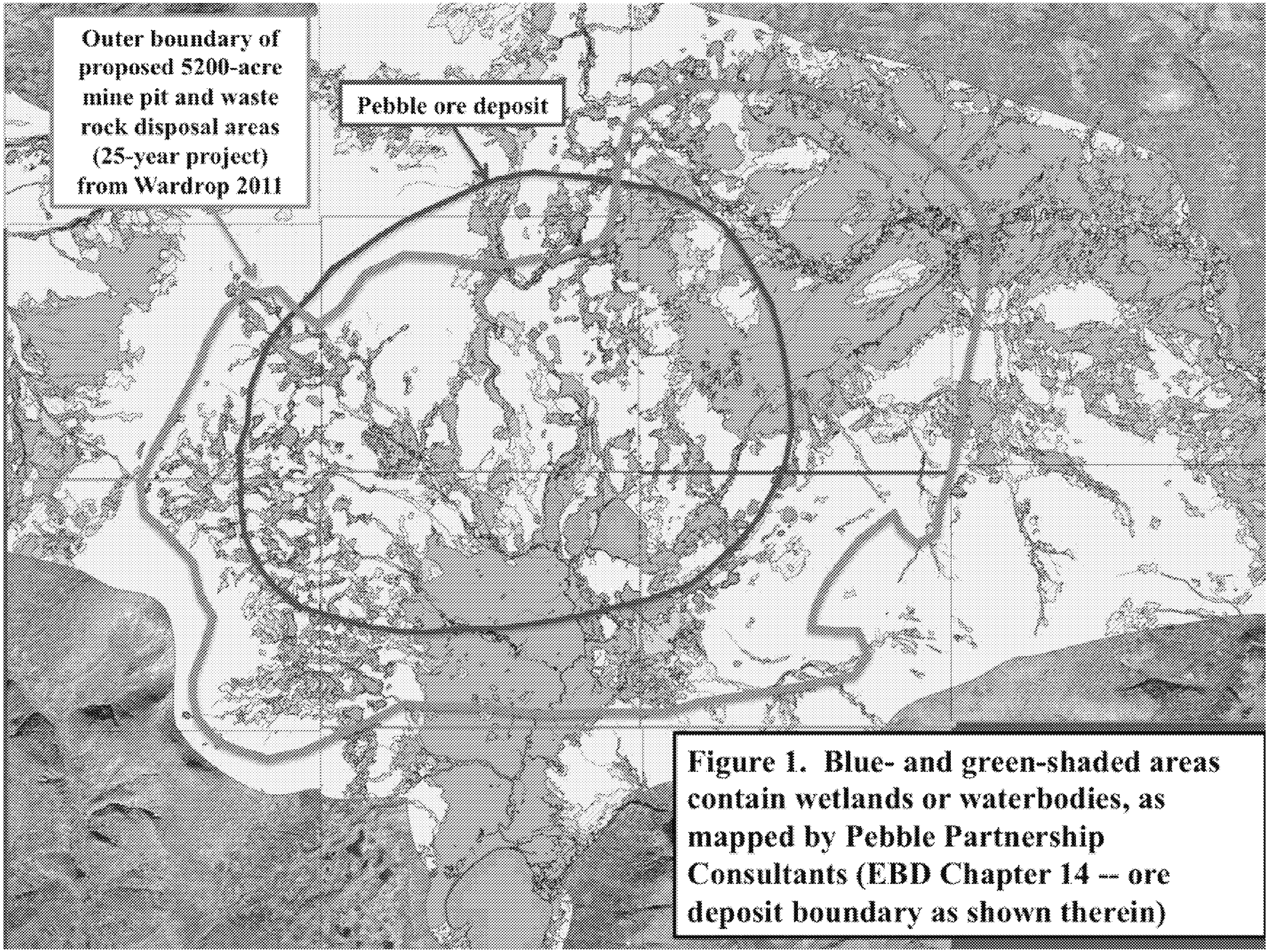

Figure 1. Blue- and green-shaded areas contain wetlands or waterbodies, as mapped by Pebble Partnership Consultants (EBD Chapter 14 -- ore deposit boundary as shown therein)

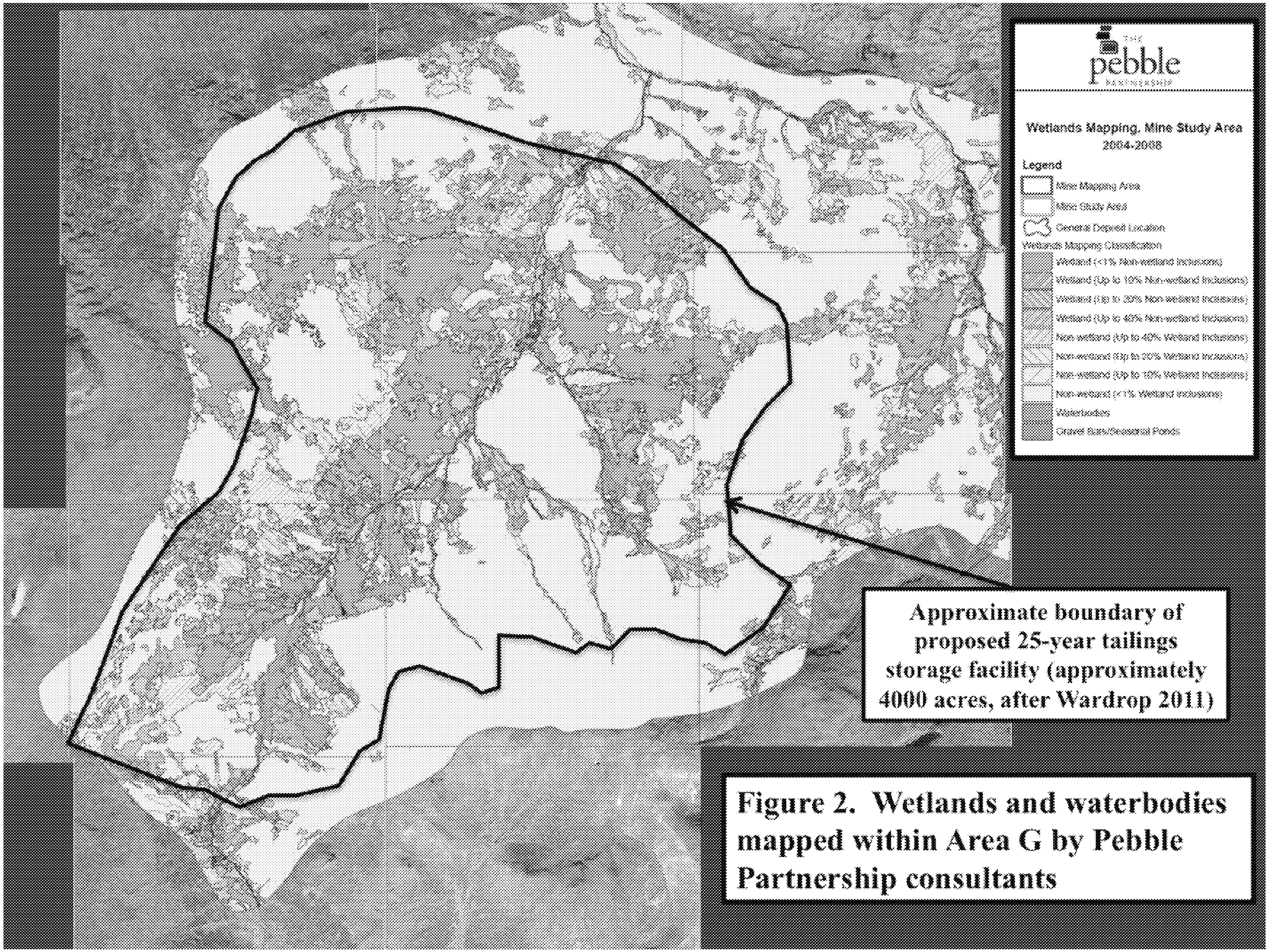

Figure 2. Wetlands and waterbodies mapped within Area G by Pebble Partnership consultants